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The purpose of this grant was to participate in a one-year planning effort to develop the experimental plan for the remainder of the DRI. The main tasks were to participate in planning meetings and to contribute to the science plan document. A proposal based on the contribution to the science plan was declined. The remainder of this document is the contribution to the DRI science plan

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Final Report for ONR grant No. N00014-07-1-0197

The Distribution of Breaking Waves in the Open Ocean

Participation in the Planning Year for High Resolution Air-Sea Interaction DRI

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The purpose of this grant was to participate in a one-year planning effort to develop the experimental plan for the remainder of the DRI. The main tasks were to participate in planning meetings and to contribute to the science plan document. A proposal based on the contribution to the science plan was declined. The remainder of this document is the contribution to the DRI science plan.

Contribution to DRI Science Plan

Helikite-based Measurements for Surface Displacement and Wave Breaking

We will make measurements of surface displacement and the distribution of breaking wave crests as a function of crest speed. Measurements will be made using infrared (IR) and video techniques with a large field of view. Measurements with image dimensions O(100 m) will be made from a tethered helium-filled kite, or helikite, deployed either from FLIP or a ship. The large area measurements will be used to gather wave breaking statistics and track individual events for comparison to radar measurements of the wave field made from FLIP or the ship. The helikite instrumentation will include a sensor to measure surface displacement.

A key requirement to achieve the DRI objectives is the ability to derived phase-resolved surface displacement from the radar measurements. This requirement implies that the ability to measure surface displacement from the helikite within the footprint of the radar will be extremely valuable. We will use a combination of GPS, attitude sensors, and a laser ranging device to provide surface displacement at a point below the helikite.

The helikite system is being developed under a FY07 DURIP. The photographs in Figure 1 show examples of a commercially available helikite and sensor mounting platform. In order for the helikite measurements to be coincident with the useable footprint of the radar on FLIP, we will need to be able to image the surface at least 100 m from FLIP. A FLIP-based deployment scheme to achieve this requirement is shown in Figure 2. The helikite is designed to fly with the tether at a 45° angle and the nominal field of view of the cameras is 40°. With these parameters, flying the helikite at an altitude of 200 m will provide a horizontal image dimension of 150 m beginning approximately 125 m from FLIP. An alternative deployment scheme would be to fly the helikite at a lower altitude and aim the cameras at an oblique incidence angle. The choice of scenario will be made based on local testing of the helikite before deployment on FLIP.

The possibility of deploying the helikite from a ship that may be on station will also be considered. However, since the ship will likely be deployed outside of the range of the FLIP-base radar, this arrangement may not be suitable. Furthermore, this ship is likely to be tasked

with a significant amount of operational maneuvering that may not be compatible with deploying the helikite.

During the FAIRS experiment on FLIP in 2000, we used a CO_2 laser to heat a small patch on the surface within the IR field of view in order to investigate the correlation of the temperature decay time scale and breaking-generated turbulence. We found that the use of a single spot did not provide enough spatial coverage to sample all the breaking events that passed through the field of view. For the Hi-Res DRI, we will use a programmable scanning galvanometer to provide larger area coverage for the laser-heating. We will investigate the use of multiple spots to increase the area coverage, which we have done successfully in laboratory experiments. We will also evaluate lines and an area-extensive patch by using a scanner and beam expander.

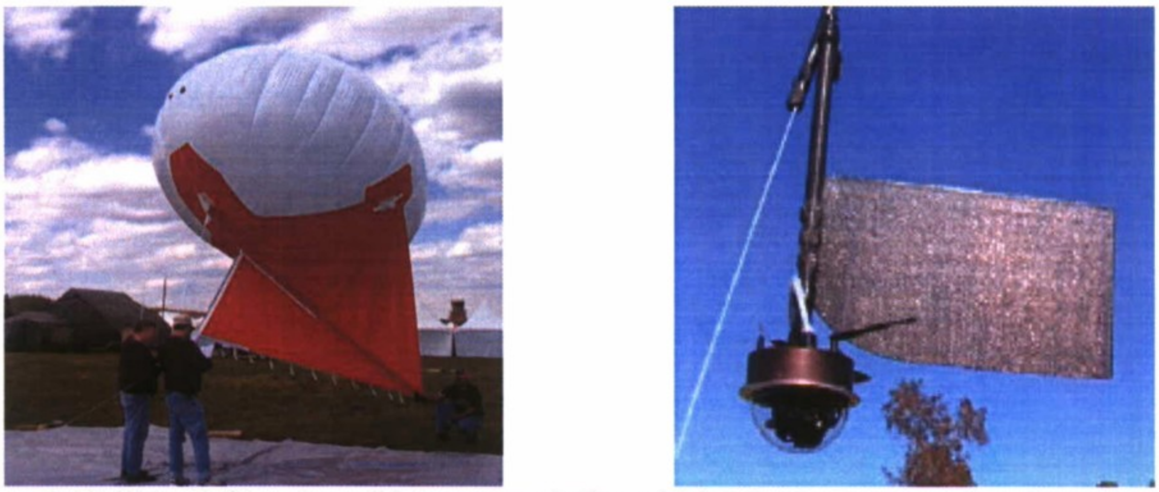

Figure 1. Helikite (left) and candidate sensor platform (right) for deployment of surface displacement and imaging sensors.

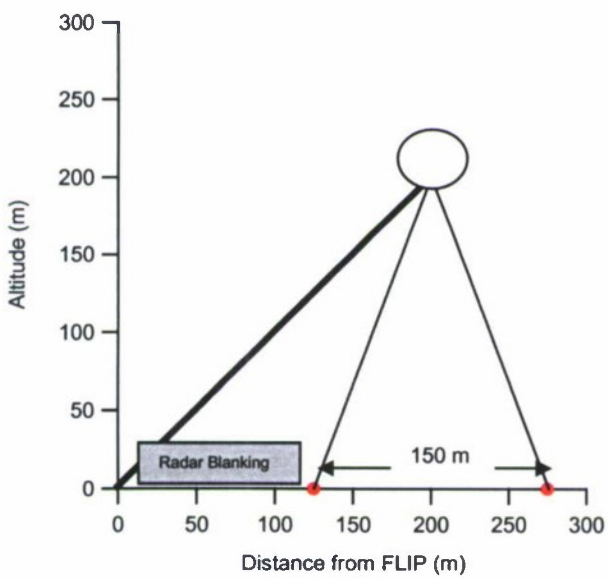

Figure 2. Schematic diagram showing possible configuration for deploying the helikite from FLIP, which provides measurements within the useable footprint of the FLIP-base radar.